Chemosystematic Notes on the Asteraceae I
New Correlations in Subtribes of the Heliantheae

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Abstract

Among the Heliantheae with paleaceous receptacles, Polyacetylenes of the dehydrofalcarinone type containing a ketone unit are correlated with the redelimited subtribes Helianthinae containing *Lagascea* and the Galinsoginae containing *Alloispermum*. The Neurolaeninae containing *Calea* lack such polyacetylenes but contain thymol derivatives. *Coulterella* with a thiophene type of polyacetylene and thymol derivatives is placed in a subtribe Coulterellinae near the epaleaceous subtribes Pectidinae and Flaveriinae.

Chemosystematics has enjoyed some important success in the tribe Heliantheae. In the sesquiterpene lactones Herz (1977) has shown that the Ambrosanolides are essentially restricted to the subtribe Ambrosiinae and the Helenolides are almost completely restricted to the subtribe Gaillardiinae. One group of polyacetylenes, the epoxysulfones are found only in the Gaillardiinae (Bohlmann, 1973; Swain & Williams, 1977). The correlations were possible because of the comparatively accurate concepts of the subtribes in the traditional classifications. Chaotic concepts of other subtribes in the Heliantheae has prevented meaningful interpretation of other chemical data, however.

The recent revisions of the tribes Heliantheae (Stuessy, 1977) and Helenieae (Turner & Powell, 1977) for the Reading Symposium provide a number of changes. The most significant was the reduction of the artificial subtribe Lagasceinae which had contained two genera, *Lagascea* and *Coulterella* having single-flowered heads. Unfortunately Stuessy's placement of *Lagascea* in the Verbesininae was already superceded by the time of publication by his correct though perhaps inadvertent placement of the genus

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in the subtribe Helianthinae (Stuessy, 1976). Stuessy in both treatments, following the suggestions of King & Robinson, removed the genus *Coulterella* to a position near the genus *Flaveria* which he placed in the Senecioneae.

The present paper accepts the position of *Lagascea* in the Helianthinae but utilizes more extensively new data from a survey of the complete tribe Heliantheae by H. Robinson (in press) which is based heavily on anatomical characters. Significant rearrangements correlated with chemistry include: the redelimitation of Helianthinae to exclude *Encelia* and its immediate relatives, transfer of *Schistocarpha* to the Galinsoginae where it resides with *Bebbia* and *Tridax*, the segregation of *Alloispermum* of the Galinsoginae from *Calea* which is transferred to the Neurolaeninae (Robinson, 1978), the positioning of the Pectidinae and Flaveriinae as subtribes of the Heliantheae, and the recognition of subtribe Coulterellinae for the monotypic genus *Coulterella*. The full discussion of the changes should be sought in the paper by H. Robinson (in press).

Chemical analyses provided by Bohlmann of *Lagascea* (1973, 1978a) and *Coulterella* (1978b in press) are of particular interest in view of the juxtaposition in older classifications and in view of the distinctive groups in which they have been placed recently. The Helianthinae have paleaceous receptacles representative of the traditional tribe Heliantheae. The Flaveriinae lack paleae on the receptacles and are representative of the once segregated tribe Helenieae. The character of the paleae is of primary importance in the tribe but cannot be determined in single flowered heads like those of *Lagascea* and *Coulterella*.

Chemical analysis of *Lagascea* has shown a polyacetylene of the dehydrofalcarinone type containing a ketone unit (fig. 1). The genus also contains various diterpenes, coumarins, flavanoids and sesquiterpenes. In contrast, *Coulterella* contains in addition to the widespread pentaynene a polyacetylene of the thiophene type (fig. 5) and several phenolics of the thymol type. (figs. 7 & 8). All of these show some significant correlations with the revised subtribal classification of the Heliantheae (Robinson, in press).

The dehydrofalcarinones or similar compounds have been reported from *Galinsoga*, *Tridax*, *Bebbia*, *Jaegeria*, and *Alloispermum* of the Galinsoginae, *Lagascea*, *Helianthus*, *Viguiera*, *Tithonia*, and *Simsia* of the Helianthinae and *Iva* of the Ambrosiinae. With the exception of *Iva*, this polyacetylene in addition to other constituents seems a marker for the two subtribes Helianthinae and Galinsoginae. In the same two subtribes the thiophenes are notably absent. In *Iva* which is not closely related to the Helianthinae or the Galinsoginae a thiophene occurs with the dehydrofalcarinone.

Encelia and *Flourensia* which have been excluded from the Heliantheae on anatomical basis have been examined chemically. The results are limited but dehydrofalcarinone types of polyacetylenes have not been found. *Calea* which has been separated from *Alloispermum* and removed to the subtribe Neurolaeninae has been examined a number of times, and as in *Nuerolaena,* (Bohlmann 1978b in press) there are only polyacetylenes lacking ketone units (figs. 2, 3, & 4) and there are no thiophenes.

Thymol derivatives are common in the Eupatorieae, Astereae and Inuleae but appear to be uncommon in the Heliantheae. They are now known from *Coulterella, Calea, Neurolaena, Porophyllum, Helenium* and *Gaillardia.* Of these, *Galea* and *Neurolaena* are placed together in the Neurolaeninae in the paleaceous Heliantheae. *Porophyllum* is a member of the Pectidinae, a subtribe near the Flaveriinae among the epaleaceous Heliantheae. *Helenium* and *Gaillardia* are in the Gaillardiinae which differs by uncarbonized achenes. Certain features of *Coulterella* such as the fused involucre and the lack of sesquiterpene-lactone-bearing capitate glands are seen also in the Pectidinae and Flaverinae. *Coulterella* contains only a simple thiophene while the Pectidinae and Flaveriinae are notable for their complex thiophenes (fig. 6). Anatomy would dictate a separate subtribal status for *Coulterella* but chemical and anatomical data place the subtribe close to the Pectidinae and the Flaveriinae.

1 $H_2C=CHCO\ C\equiv C\ _2CH_2CH=CH\ (CH_2)_5\ CH=CH_2$

as in Alloispermum integrifolium and A. scabrum

2 $H_3C\ (C\equiv C)_5\ CH=CH_2$

as in Calea urticifolia

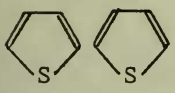
3 $H_3C\ CH=CH\ (C\equiv C)_2(CH=CH)_2\ (CH_2)_4\ CH=CH_2$

4 $ROCH_2\ CH=CH\ (C\equiv C)_2\ (CH=CH)_2\ (CH_2)_4\ CH=CH_2$

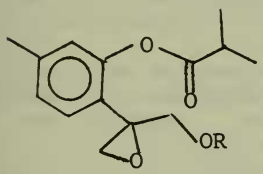
R = H, Ac as in Calea zacatechichi

5 $H_3C\ C\equiv C$  $(C\equiv C)_2\ C=CH_2$

as in Coulterella

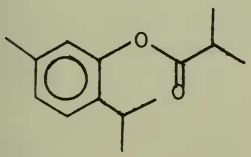
6  $C\equiv C\ CH=CH_2$

as in Tagetes, Dyssodia & Flaveria

7 

as in Coulterella

R = Ac, $COCHMe_2$

8 

as in Coulterella

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